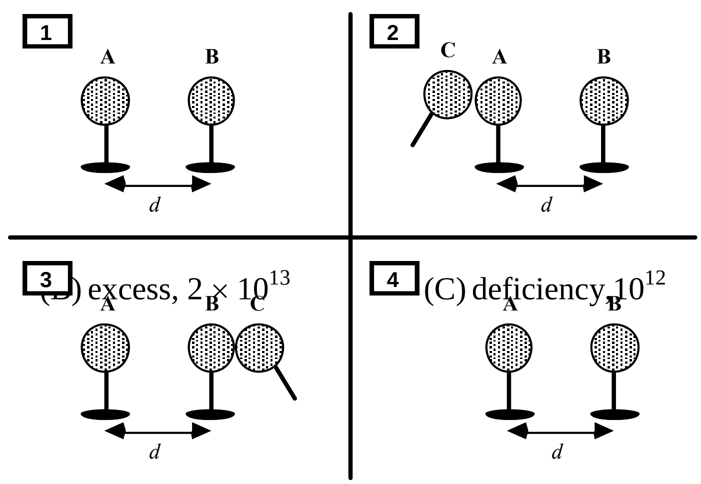
Prince Sultan University
PHY 205
Final Examination
Semester II, Term 092
Thursday, June 6, 2010
Time Allowed: 120 minutes

<u>Part 1.</u>

Please read each question carefully. Each question worth's 1 point.
For the following questions, please circle ◯ the correct answer.

1. Consider three identical metal spheres, **A**, **B**, and **C**. Sphere **A** carries a charge of **–2.0 μC**; sphere **B** carries a charge of **–6.0 μC**; and sphere **C** carries a charge of **+5.0 μC**. Spheres **A** and **B** are touched together and then separated. Spheres **B** and **C** are then touched and separated. Does sphere **C** end up with an excess or a deficiency of electrons and how many electrons is it?



(A) deficiency, 6×10^{13} (B) excess, 2×10^{13} (C) deficiency, 10^{12}
(D) excess, 3×10^{13}
(E) deficiency, 3×10^{12}

2. In Frame **1**, two identical conducting spheres, **A** and **B**, carry equal amounts of excess charge that have the same sign. The spheres are separated by a distance ***d***; and sphere **A** exerts an electrostatic force on sphere B that has a magnitude ***F***. A third sphere, **C**, which is handled only by an insulating rod, is introduced in Frame **2**. Sphere **C** is identical to **A** and **B** except that it is ***initially uncharged***. Sphere **C** is touched first to sphere **A**, in Frame **2**, and then to sphere **B**, in Frame **3**, and is finally removed in Frame **4**.

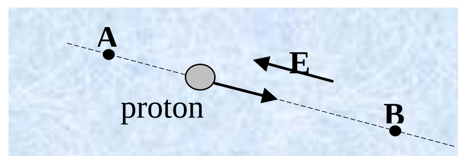
Determine the magnitude of the electrostatic force that sphere **A** exerts on sphere **B** in Frame **4**.

(A) $F/2$ (B) $3F/4$ (C) zero
(D) $F/3$ (E) $3F/8$

3. In the figure, point **A** is a distance L away from a point charge Q. Point **B** is a distance $4L$ away from Q. What is the ratio of the electric field at **B** to that at **A**, $E_\mathbf{B}/E_\mathbf{A}$?

(A) 1/16 (B) 1/3 (C) zero
(C) *1/9* (D) ¼
(E) This cannot be determined since neither the value of Q nor the length L is specified.

4. A proton moves in a constant electric field **E** from point **A** to point **B**. The magnitude of the electric field is $\mathbf{4.2 \times 10^4}$ **N/C**; and it is directed as shown in the drawing, the direction opposite to the motion of the proton. If the distance from point **A** to point **B** is **0.18 m**, what is the change in the proton's electric potential energy, $\mathbf{EPE_A - EPE_B}$?



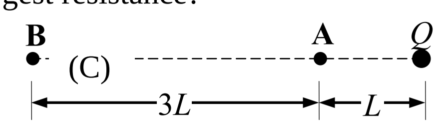
(A) $+2.4 \times 10^{-15}$ J (B) $+1.2 \times 10^{-15}$ J (C) -1.2×10^{-15} J
(D) -2.4×10^{-15} J (E) -1.8×10^{-15} J

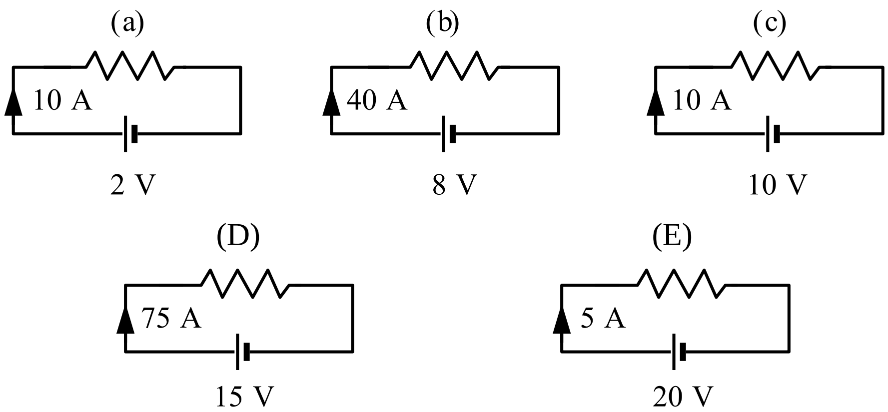
5. A parallel plate capacitor is fully charged at a potential $\boldsymbol{V}$. A dielectric with constant $\boldsymbol{\kappa} = \mathbf{4}$ is inserted between the plates of the capacitor while the potential difference between the plates remains constant. Which one of the following statements is false concerning this situation?

(A) The energy density remains unchanged.
(B) The capacitance increases by a factor of four.
(C) The stored energy increases by a factor of four.
(D) The charge on the capacitor increases by a factor of four.
(E) The electric field between the plates increases by a factor of four.

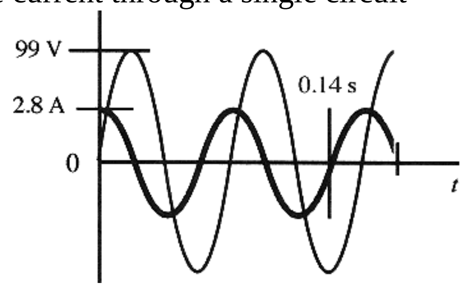
6. Which one of the following circuits has the largest resistance?

(A) (B) (C)





7. The graph shows the voltage across and the current through a single circuit element connected to an ac generator.
Determine the frequency of the generator.



(A) 0.14 Hz (B) 25.0 Hz
(C) 12.5 Hz (D) 7.14 Hz
(E) 50 Hz

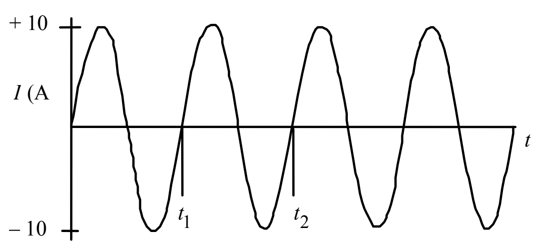
8. Use the information given in question **7** to find the reactance of this element?

(A) 20 Ω (B) 30 Ω (C) 40 Ω
(D) 35 Ω (E) 25.0 Ω

9. Use the information in question **7** to identify the circuit element.

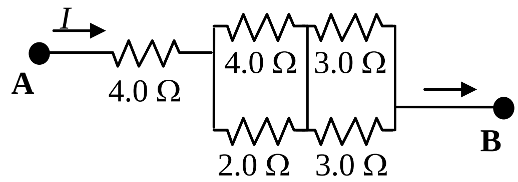
(A) The element is a 25-Ω resistor. (B) The element is a 360-μF capacitor.
(C) The element is a 35-Ω resistor. (D) The element is a 510-μF capacitor.
(E) The element is a 0.45-H inductor.

10. The figure shows variation of the current through the heating element with time in an iron when it is plugged into a standard **120 V, 60 Hz** outlet. What is the resistance of the heating element?



(A) 24 Ω (B) 17 Ω
(C) 1.8 Ω (D) 7.1 Ω
(E) 12 Ω

11. Five resistors are connected as shown. What is the equivalent resistance between points **A** and **B**?

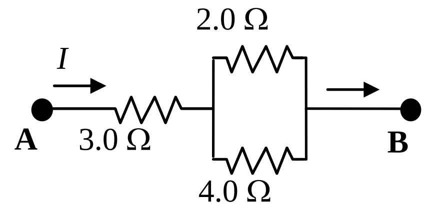


(A) 6.8 Ω (B) 2.1 Ω
(C) 9.2 Ω (D) 16 Ω
(E) 3.4 Ω

12. Resonance in a series RLC circuit occurs when

A) X_L is greater than X_C. B) X_C is greater than X_L.
C) $(X_L - X_C)$ is equal to R^2. D) $(X_L - X_C)^2$ is equal to R^2.
E) X_C equals X_L.

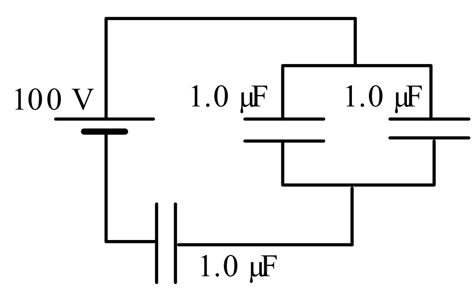
13. Three resistors are connected as shown in the figure. The potential difference between points **A** and **B** is **26 V**.
How much current flows through the **3-Ω** resistor?



(A) 2.0 A (B) 6.0 A (C) 10.0 A
(D) 4.0 A (E) 8.7 A

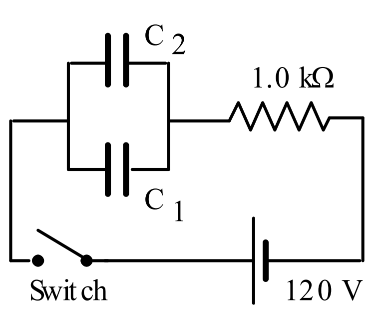
14. What is the equivalent capacitance of the combination of capacitors shown in the circuit?

(A) 0.37 μF (B) 0.67 μF
(C) 3.3 μF (D) 2.1 μF
(E) 4.6 μF



15. An RC circuit consists of a resistor with resistance **1.0 kΩ**, a **120-V** battery, and two capacitors, **C_1** and **C_2**, with capacitances of **20.0 μF** and **60.0 μF**, respectively. Initially, the capacitors are uncharged; and the switch is closed at ***t* = 0 s.**

What is the time constant of the circuit?

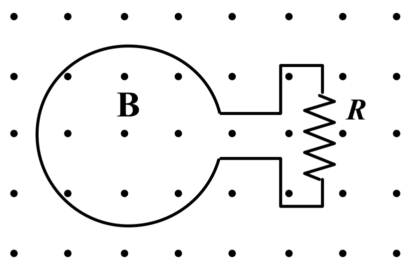


(A) 1.0×10^{-2} s (B) 6.0×10^{-2} s (C) 3.0×10^{-1} s
(D) 2.0×10^{-2} s (E) 8.0×10^{-2} s

16. An electron travels through a region of space with no acceleration. Which one of the following statements is the best conclusion?

(A) Both **E** and **B** must be zero in that region.
(B) **E** must be zero, but **B** might be non-zero in that region.
(C) **E** and **B** might both be non-zero, but they must be mutually perpendicular.
(D) **B** must be zero, but **E** might be non-zero in that region.
(E) **E** and **B** might both be non-zero, but they must point in opposite directions.

17. The figure shows a uniform, **3.0-T** magnetic field that is normal to the plane of a conducting, circular loop with a resistance of **1.5 Ω** and a radius of **0.024 m**. The magnetic field is directed out of the paper as shown. **Note**: The area of the non-circular portion of the wire is considered negligible compared to that of the circular loop.



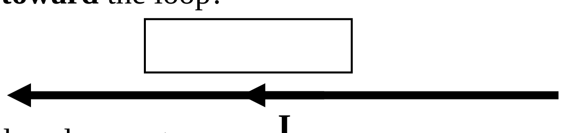
What is the magnitude of the average induced **emf** in the loop if the magnitude of the magnetic field is doubled in **0.4 s**?

(A) 0.43 V (B) 0.014 V (C) 0.038 V
(D) 0.65 V (E) 0.027 V

18. Use the information given in question **16**, to find the average current around the loop if the magnitude of the magnetic field is doubled in **0.4 s**?

(A) 2.8×10^{-3} A, clockwise (B) 9.0×10^{-3} A, clockwise
(C) 4.5×10^{-3} A, clockwise (D) 9.0×10^{-3} A, counterclockwise
(E) 4.5×10^{-3} A, counterclockwise

19. A long, straight wire is in the same plane as a rectangular, conducting loop. The wire carries a constant current I as shown in the figure. Which one of the following statements is true if the wire is suddenly moved **toward** the loop?



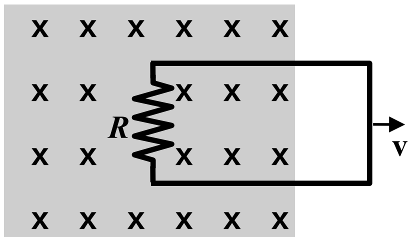
(A) There will be no induced emf.
(B) There will be an induced emf, but no induced current.
(C) There will be an induced current which is clockwise around the loop.
(D) There will be an induced current which is counterclockwise around the loop.
(E) There will be an induced electric field which is clockwise around the loop.

20. A circuit is pulled with a **16-N** force toward the right to maintain a constant velocity ***v***. At the instant shown, the loop is partially in and partially out of a uniform magnetic field that is directed into the paper. As the circuit moves, a **6.0-A** current flows through a **4.0-Ω resistor**. Which one of the following statements concerning this situation is true?

(A) The temperature of the circuit remains constant.
(B) The induced current flows clockwise around the circuit.
(C) Since the circuit moves with constant speed, the force **F** does zero work.
(D) If the circuit were replaced with a wooden loop, there would be no induced emf.
(E) As the circuit moves through the field, the field does work to produce the current.

21. Use the information in question **19**, to find the magnitude of ***v*** (velocity)?

(A) 1.5 m/s (B) 6.4 m/s (C) 12 m/s
(D) 3.0 m/s (E) 9.0 m/s

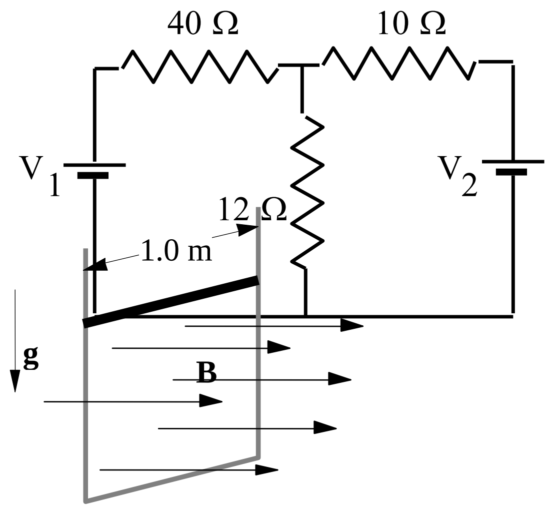


Part 2.

P.1. Unpolarized light with an average intensity of **750.0 W/m^2** enters a polarizer with a vertical transmission axis. The transmitted light then enters a second polarizer. The light that exits the second polarizer is found to have an average intensity of **125 W/m^2**. What is the orientation angle of the second polarizer relative to the first one? ***(4 points)***

***Answer (with units)*___________________**

P.2. A 2.0-kg rod that has a length of 1.0 m and a resistance of 4.0 Ω slides with *constant speed* down a pair of frictionless vertical conducting rails that are joined at the bottom. Other than the rod, the rest of the circuit is resistanceless. A uniform magnetic field of magnitude 3.0 T is perpendicular to the plane formed by the rod and the rails as shown. Determine the speed of the rod. ***(5 points)***

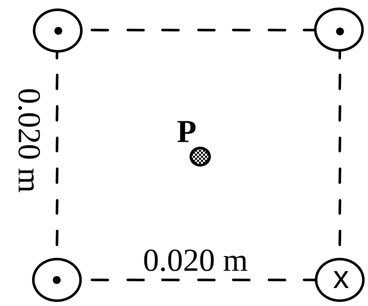


***Answer (with units)*____________________**

P.3. Three resistors and two **10.0-V** batteries are arranged as shown in the circuit diagram. What is the power delivered by each battery?
(4 points)

Answer (with units)____________________

P.4. Four long, straight wires are parallel to each other; and their cross-section forms a square. Each side of the square is **0.020 m** as shown in the figure. If each wire carries a current of **8.0 A** in the direction shown in the figure, determine the magnitude of the total magnetic field at P, the center of the square. ***(5 points)***



Answer (with units)____________________